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Risk Analysis of Occupational Health and Safety Using Hazard Identification, Risk Assessment and Risk Control (HIRARC) Method (Case Study in PT Barokah Galangan Perkasa)

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A B S T R A C T

PT Barokah Galangan Perkasa is a company located in East Kalimantan that is engaged in the manufacturing, repair, and maintenance of ships. The welding activity is the most dominant in shipbuilding, but the implementation of the occupational health and safety (OHS) system is not optimal. There have been several work accidents in the upper accommodation and cargo oil tank areas, such as falling from a height, being hit by welding sparks, and an electrical short circuit. The working conditions in this area are quite risky. Therefore, research on risk analysis is needed. HIRARC is a method for identifying a problem that is assessed at risk based on the likelihood and severity where the results of the assessment can determine the level of risk and give risk control for each work activity. Research results show that there were 40 potential hazards in the upper accommodation area with 77% low risk level, 12% moderate risk level, 8% high risk level, and 3% very high risk level. While in the cargo oil tank area there was 37 potentials hazard with 84% low risk level, 13% moderate risk level, and 3% high risk level. By knowing the risk level, companies can identify work activities that require prioritized improvement. They can also determine appropriate control to prevent the occurrence of such risks. Risk control in the upper accommodation area can be achieved through the implementation of administrative controls, utilization of PPE, and technical engineering controls.

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1. INTRODUCTION

The increase in the maritime economic sector in Indonesia contributes to the growth of the shipping industry especially in the shipyard industry that builds or repair ship. This causes the necessity of occupational health and safety (OHS) implementation to avoid the risk of work accidents that occur. Shipyard company needs to improve quality and analyze occupational health and safety risk, so it can continue to compete. In order to be able to analyze risk occupational health and safety, then needed analysis as well as mitigation effectively and efficiently.

Occupational health and safety (OHS) is one way to protect employees from the dangers of work accidents and occupational diseases while working. Sometimes the implementation of occupational health and safety is not considered in employee performance so it will interfere with employee work productivity. The health of employees can be disrupted due to work-related illnesses, as well as due to neglected work safety (Munandar et al., 2014).

PT Barokah Galangan Perkasa is a company engaged in the field of shipbuilding and ship repairs. This company is located in Pulau Atas Village, Sambutan District, City of Samarinda, East Kalimantan. One of the activities in this company is welding. Several workplace accidents have occurred, such as near-falls from heights, falling of material plates, exposure to welding sparks, and bodily injuries during the welding process and ship repairs after usage. Additionally, the tanks used for transporting oil pose a risk of explosion. Based on initial observation, the implementation of occupational health and safety (OHS) in this company is not optimal, indicated by the inadequate use of personal protective equipment (PPE) by workers. Therefore, a study on OHS risk analysis through hazard identification and risk assessment needs to be conducted. This is intended to identify the hazards present in the company, particularly in the upper accommodation area and oil cargo tank, and determine the risk levels associated with the activities there. Subsequently, appropriate control measures can be taken to minimize the occurrence of risks. The implementation of good OHS management plays a role in minimizing work accidents (Indrayani & Kusumojanto, 2020).

There are several OHS risk analysis methods, namely Hazard Identification and Risk Assessment (HIRA), Hazard and Operability Study (HAZOP), and Hazard Identification, Risk Assessment and Risk Control (HIRARC). This method is commonly used to identify potential hazards and provide an assessment of risk based on the level of probability of occurrence and the severity of the risk. In this study, the HIRARC method is utilized as a means of preventing or reducing workplace accidents. HIRARC is a method that begins by identifying the specific type of work activity, followed by identifying the source of the hazard, and ultimately assessing the associated risks. The ultimate goal is to obtain a comprehensive understanding of the risks involved to implement effective control measures (Kabul & Yafi, 2022). Furthermore, it is considered more appropriate and meticulous as it describes the hazards associated with each work activity. This method also provides appropriate control measures for each potential hazard to minimize the risk levels from high to low. The main objective of HIRARC is to effectively manage and mitigate potential risks to create a safer working environment (Sitepu & Simanungkalit, 2019).

The use of the HIRARC method as a tool for risk analysis has been widely applied in the maritime industry, such as in PT Pelindo Marine Service (Samudra et al., 2017), PT PAL Indonesia (Putra et al., 2019), PT Marga Surya Shipindo (Tambunan et al., 2019), and PT Dock dan Perkapalan Surabaya (Fairussihan & Dwisetiono, 2022). The research findings indicate that the HIRARC method enables prioritization of improvement efforts for activities with high-risk levels. Therefore, the HIRARC method is utilized in this study, which focuses on a case study conducted at PT Barokah Galangan Perkasa, one of the shipping companies located in East Kalimantan.

2. LITERATURE REVIEW

Occupational Health and Safety (OHS) is the effort to create a healthy and safe work environment, to reduce the probability of work accidents or illnesses caused by negligence that can lead to demotivation and decreased work productivity. OHS aims to ensure the safety and well-being of individuals within the workplace. It encompasses various aspects such as the handling of raw materials, utilization of construction equipment, production processes, and the overall work environment. The primary objective is to provide protection and ensure a safe working environment for everyone involved (Kabul & Yafi, 2022).

HIRARC is conducted on all activities to identify those that pose potential hazards and have a significant impact on occupational health and safety (Indragiri & Yuttya, 2018).

Occupational health and safety research using HIRARC has been conducted by several researchers. The use of the HIRARC method is accompanied by risk control activities that make the analysis results more meaningful with the presence of the control process (Dewantari et al., 2022).

HIRARC is a fundamental element in the occupational health and safety management system directly related to efforts to prevent and control hazards. Based on OHSAS 18001-2007, HIRARC is a methodical way of managing risk that involves three key steps: hazard identification, risk assessment, and risk control. It is crucial to identify potential hazards that may harm workers and others. The risk assessment process evaluates the likelihood of these hazards occurring and the severity of the associated risks. The risk control process enables the development and monitoring of an action plan to control and minimize risks (Wong et al., 2022).

According to the Department of Occupational Safety and Health Ministry of Human Resources Malaysia (2008), the objectives of HIRARC include identifying all factors that could endanger workers and others, considering the likelihood of hazards that could occur in specific situations and the severity of the risks that could arise, and enabling workers to plan, introduce, and oversee preventive measures to ensure that risks are controlled appropriately.

The steps of risk management using HIRARC (Suma'mur, 1995) are hazard identification (the process of examining each work area to identify all hazards inherent in a job, work areas include machinery, work equipment, laboratories, office areas, warehouses, and transportation), risk assessment (a process of assessing the risk of hazards in the workplace) and risk control (a process used to identify and control all potential workplace hazards and continuously review to ensure that their work is safe).

HIRARC offers several advantages. HIRARC gives a structured and systematic approach that allows for comprehensive and consistent identification and evaluation of potential hazards, reducing the likelihood of important risks being overlooked and ensuring that all risks are assessed on a comparable basis. Another advantage is that HIRARC gives clear prioritization of risks based on their severity and likelihood so that organizations can concentrate their resources on the most significant hazards. This results in efficient use of resources and targeted risk control efforts. Furthermore, the involvement of workers and other stakeholders in the risk management process, which is encouraged by HIRARC, promotes the incorporation of diverse perspectives and expertise. This ensures that the control measures developed are practical, effective, and acceptable to those who will be affected by them.

3. RESEARCH METHOD

This research was conducted at PT Barokah Galangan Perkasa in the upper accommodation area and oil cargo tank area. This research was conducted by filling out a questionnaire and interviewing the head of production as expert judgment.

The first step in HIRARC is hazard identification. Hazards can be defined as any condition, situation, or behavior that has the potential to cause harm, including accidents, illnesses, deaths, environmental pollution, and damage to company facilities (Ahmad et al., 2016). According to the Department of Occupational Safety and Health Malaysia (2008), in the first stage, hazard identification is carried out to identify all potential hazards, whether they originate from materials, equipment, or work systems. The 5 (five) factors of hazard sources that are included are man, method, material, machine, and environment.

The next step after identifying the sources of hazards in the workplace is to conduct a risk assessment. This step is carried out to determine the likelihood/level of risk associated with each identified hazard. This process is based on guidelines from the Australian Standard/New Zealand Standard for Risk Management (AS/NZS 3260: 2004), which is a standard from Australia (Australia Standards/New Zealand Standards 4360, 2004). There are two parameters used for risk assessment in this standard, namely the probability/likelihood of

hazard and the severity of hazard (Cooper, 2007) as seen in Table 1 and Table 2.

Table 1. Probability/likelihood of the hazard

Level	Criteria	Description
1	Rare	Almost never happened
2	Unlikely	Rarely happening
3	Possible	Can Happen every once in a while
4	Likely	Often occur
5	Almost Certain	Can happen any time

Source: AS/NZS 4360: 2004

Table 2. Severity of the hazard

Level	Criteria	Description
1	Insignificant	No injury and/or no disease caused and/or no effect on the environment, small financial loss
2	Minor	Minor injury and/or illness with mild symptoms and/or small effect on the environment, small financial loss.
3	Moderate	Moderate injury and/or chronic illness requires medical treatment and/or moderate effect on the environment, sizeable financial loss
4	Major	Serious injury and/or chronic illness require medical treatment and/or serious and long-term environmental damage
5	Catastrophic	Fatal and/or chronic diseases require serious medical treatment and/or very serious and long-term environmental damage, huge losses and very broad impacts, cessation of all activities

Source: AS/NZS 4360: 2004

From both parameters in Table 1 and Table 2, the risk assessment matrix level can be obtained as shown in Table 3.

Table 3. Risk matrix

Likelihood	Severity				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost Certain (5)	M	H	VH	VH	VH
Likely (4)	L	M	H	VH	VH
Possible (3)	L	M	H	VH	VH
Unlikely (2)	L	L	M	H	VH
Rare (1)	L	L	M	H	H

Source: AS/NZS 4360: 2004

According to the Department of Occupational Safety and Health Malaysia (2008), risk can be calculated using the following formula:

$$\text{Risk (R)} = L \times S \quad (1)$$

where: L = likelihood

S = severity

After conducting risk a assessment, the next step is to perform risk control. The purpose of risk control in Occupational Health and Safety (OHS) is to prevent or minimize the risk of accidents, illnesses, and injuries that may occur to workers or people involved in work activities. Control of risks in the HIRARC method consists of elimination, substitution, engineering, administrative control, and personal protective equipment (PPE) (Qi et al., 2013). The use of risk control measures goes from elimination to PPE, with PPE being the last option if no other appropriate risk control measure is available. This is because the use of PPE is not meant to remove potential hazards, but rather to reduce the effects caused by these hazards.

4. RESULT AND DISCUSSION

PT Barokah Galangan Perkasa is a company founded in 2002 in Samarinda, East Kalimantan, to be precise in the Pulau Atas Village, Sambutan District, City of Samarinda, East Kalimantan which is also the subsidiary of Barokah Perkasa Group. PT Barokah Galangan Perkasa is engaged in ship manufacture, repair, and maintenance.

Fig. 1. The welding process for the outer part of the upper accommodation area

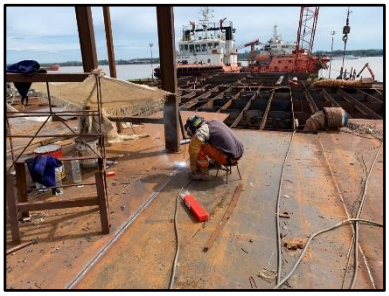

Fig. 2. The Welding process for the outer part of the oil cargo tank area

One of the activities frequently carried out by companies is welding. There are 4 stages of welding in 2 welding areas on Motor Tanker Hull H029, namely the Upper Accommodation Area and Cargo Oil Tank. The welding activities in both welding areas are described as follows:

a. Welding Preparation Stage
The preparation stage is where preparation is carried out before the welding process such as the preparing welding check (preparing the material side to be welded), welding machine, ground cable, electrode cable, electrode type, polarity type, the magnitude of the welding current, and welding auxiliary tools to be used.

b. Use of Welding PPE
The use of Personal Protective Equipment (PPE) in this stage is mandatory for operators to protect part or all of their bodies from potential or work-related hazards. PPE used in welding on Motor Tanker Hull H029 includes welding helmets, aprons, welding gloves, safety shoes, body harnesses, and welding masks.

c. Welding Process

The welding process at PT Barokah Galangan Perkasa, specifically the work process on Motor Tanker Hull H029 with a load capacity of 7000 KL in the Upper Accommodation Area and Cargo Oil Tank. The use of PPE is almost the same except for the Body Harness in the Upper Accommodation Area due to the welding being performed at a height.

d. Welding Completion Stage

The completion stage is carried out after the welding process on the ship by cleaning the welding slag with a slag hammer or hand grinder in several parts.

The results of the analysis based on HIRARC for 4 activities in these areas can be seen in Table 4 and Table 5.

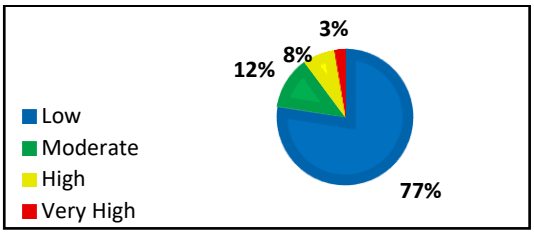

Fig. 3. Overall risk percentage in upper accommodation area

Based on research results it was obtained 40 risks in the upper accommodation area i.e. 31 levels of low risk, 5 moderate risk levels, 3 high risk level, and 1 very high risk level.

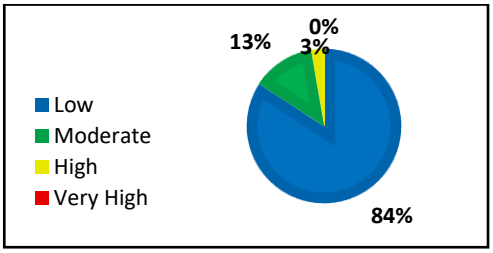

Fig. 4. Overall risk percentage in cargo oil tank area

Whereas, in cargo oil tank area, there was obtained 37 risk with 31 low risk levels, 5 moderate risk levels , and 1 high risk levels. In the oil cargo tank area, there is a risk associated with the use of Personal Protective Equipment (PPE).

Table 5. HIRARC analysis for upper accommodation area

No	Activity Name	Work Activity	Hazard	Risk	Impact	L	S	R	Risk Level	Risk Control
1	Stage Preparation Welding	Lifting or moving plate material	Plate materials	Work-Musculoskeletal Disorders	Pain in the back and shoulders	1	1	1	Low	Teaching safe lifting techniques.
		Position the plate material according to the welding stage	Plate materials	Scratched material end	Minor injuries bleeding	1	1	1	Low	Use PPE (*safety* hand gloves)
				Crushed material	bruises	1	1	1	Low	Use PPE (*Safety Shoes)*
		Cutting plate material to size	Cutting material flakes	inhaled flakes small	Respiratory disturbance	4	1	4	Low	Clean up the cutting debris promptly to prevent it from scattering
			Leftover materials piece	Crushed material	Bruises	1	1	1	Low	Keeping feet approximately ± 50 cm apart while cutting
				Scratched or cut	Minor injuries	1	2	2	Low	Grinding the edges of plates into a radius shape
		Choose type electrodes and types polarity	Wrong choice Welding electrode	short circuit	Fire	1	1	1	Low	Supervision by the Production Manager to ensure the use of appropriate electrodes before starting the welding process
			Wrong choice Welding polarity	short circuit	Fire	1	1	1	Low	Supervision by the Production Manager to ensure the correct polarity before starting the welding process
		Prepare component welding machine	Messy welding wires	Stumble cable	Minor injuries	1	1	1	Low	Arranging the position of cables to prevent obstruction during work
			Wet work area floor	Slip	bruises	1	1	1	Low	Drying wet floor areas Ensuring a dry floor and no exposed cables

Table 5. HIRARC analysis for upper accommodation area (cont.)

No	Activity Name	Work Activity	Hazard	Risk	Impact	L	S	R	Risk Level	Risk Control
		Prepare component welding machine	Plate Materials	Pinched welding components	Minor injuries	1	1	1	Low	Teaching safe material handling, such as carrying plates together with other workers
		Adapt big its small current welding	Welding cable is chipped	short circuit	Fire	1	1	1	Low	Checking the safety of cables and electrical connections before starting work
			Welding cable is chipped	short circuit	Fire	1	1	1	Low	Checking the safety of cables and electrical connections before starting work
			Tranformator AC/DC	short circuit	electrocuted	1	1	1	Low	Checking the transformer suitability for welding before starting work
						1	4	4	High	a. Conduct *safety talks*

2	Use of Welding PPE		Not wearing a welding helmet	Exposed welding beam	vision Disturbance					b. Use welding helmet as PPE c. Supervise the use of PPE
			Not wearing a welding apron	Caught welding splash	Burn injury on the body	1	3	3	Moderate	a. Conduct *safety talks* b. Use welding apron as PPE c. Supervise the use of PPE
		Wearing Protective Gear Self	Not wearing *Safety* Shoes	Caught welding splash	Burn injury on the leg	1	2	2	Low	a. Conduct *safety talks* b. Using PPE (*Safety Shoes)* c. Supervise the use of PPE
			Not wearing a Mask	inhaled smoke smell	inhaled welding pollution	2	2	4	Low	a. Conduct safety talks b. Use PPE (mask) c. Supervise the use of PPE
			Not wearing *Wearpack*	Caught welding splash	Burns on the body	1	2	2	Low	a. Conduct *safety talks* b. Using PPE (*Wearpack)* c. Supervise the use of PPE
			Not wearing welding hand gloves	Burnt	Burns	4	1	4	Low	a. Conduct *safety talks* b. Using PPE (welding hand Gloves) c. Supervise the use of PPE
		Wearing Protective Gear Self	Not wearing Welding goggles	Exposed welding beam	Vision disturbance	1	3	3	Moderate	a. Conduct *safety talks* b. Use welding goggles PPE c. Supervision use of PPE
			Not wearing *Body harnesses*	fell from Height	Damage nerves, broken Bones, Death	1	4	4	High	a. Conduct *safety talks* b. Use PPE *body harness* c. Supervision use of PPE

Table 5. HIRARC analysis for upper accommodation area (cont.)

No	Activity Name	Work Activity	Hazard	Risk	Impact	L	S	R	Risk Level	Risk Control
3	Welding Process	Welding on the Upper Accommodation Area on the inside	Installation electrode	stung electricity	electrocuted	1	1	1	Low	Conduct supervision of the welding machine and ensure the use of appropriate electrodes.
			Wet work area floor	fell	Serious injury	1	3	1	Moderate	a. Drying wet floor areas b. Ensure floor dry and no frayed cable
			Wet work area floor	fell	Serious injury	1	3	1	Moderate	a. Drying wet floor areas
			Welding cables scattered	Stumble cable	Minor injuries	1	1	1	Low	b. Ensure floor dry and no frayed cable b. Add internal lighting

			Insufficient light	Welding hit hand worker	Burns	1	1	1	Low	a. Conduct *safety talks* b. Use welding helmet as PPE c. Supervise the use of PPE
			Welding light fire (light radiation)	See light radiation continuously	Irritated eyes, cataracts, blindness	1	1	1	Low	a. Wearing PPE b. Stretch before work c. Supervision in processing
			Welding posture not ergonomic	Work-Musculoskeletal Disorders	Pain in the back, shoulders & neck	4	1	4	Low	a. Wearing back support b. Stretching before starting work. c. Supervision during the work process
			Hot scorching Sun	Getting exposed to hot parts	Burns	2	2	4	Low	a. Supervision of workers not wearing appropriate clothing (long sleeves) b. Installing tarps to avoid overheating
		Welding on the Upper Accommodation Area on the outside	Welding with height	Fell	Serious injury injury even death	2	5	10	Very High	a. Conduct *safety talks* b. Teaching proper positioning based on wind direction. c. Using appropriate welding PPE d. Monitoring the use of PPE. e. Enforcing regulations (warnings), changing wages and bonuses if workers are not compliant.
			PPE (*Body harness*) is not used properly	Fell	Serious injury injury even death	1	4	4	High	a. Supervision of workers not wearing body harness (as PPE is provided in the Shipyard) b. Enforcing regulations (warnings), changing wages and bonuses if workers are not compliant.

Table 5. HIRARC analysis for upper accommodation area (cont.)

No	Activity Name	Work Activity	Hazard	Risk	Impact	L	S	R	Risk Level	Risk Control
4	Stage Completion Welding	Cleaning welded parts	Blow Hammer Slag	hit	Wounds, bruises	1	1	1	Low	Supervision of workers not wearing safety glasses
			Hot welded material	Touched	Burns	1	1	1	Low	a. Conduct *safety talks* b. Supervision by ensuring proper welding results
			Cleaned weld crust	Caught eye	Vision Disturbance	1	1	1	Low	Ensuring operators wear safety glasses

			Noisy Voice grinding	Noise	Hearing Disturbance	1	3	3	Moderate	Supervision of workers not wearing ear protection such as earmuffs
			splash fire grinding	Touched	Burns	1	1	1	Low	Wearing appropriate safety PPE and conducting supervision
		Grinding welded parts.	Grinding wheels	Being hit by grinding wheel fragments	Serious injury bleeding	1	1	1	Low	a. Conduct *safety talks* b. Providing first aid kits c. Workers must be more focused and cautious during work
				Cut	Bleeding	1	1	1	Low	a. Conduct *safety talks* b. Providing first aid kits c. Workers must be more focused and cautious during work
			The hand grinder cable is peeled off	stung electricity	electrocuted	1	1	1	Low	Supervision of electrical safety before starting work

Table 6. HIRARC analysis for oil cargo tank area (cont.)

No	Activity Name	Work Activity	Hazard	Risk	Impact	L	S	R	Risk Level	Risk Control
1	Stage Preparation Welding	Lifting or moving plate material	Plate materials	WMSD	Pain in the back and shoulders	1	1	1	Low	Teaching safe lifting techniques
		Position the plate material according to the welding stage		scratched material end	Minor injuries bleeding	1	1	1	Low	Using safety gloves as PPE
				Crushed material	bruises	1	1	1	Low	Using safety gloves as PPE
		Cutting plate material to size	Cutting material flakes	inhaled flakes small	Respiratory Disturbance	4	1	4	Moderate	Cleaning up the cutting debris promptly to prevent it from scattering
			Leftover materials piece	Crushed material	bruises	1	1	1	Low	Keeping feet about ±50 cm away while cutting
				Scratched or cut	Minor injuries	1	2	2	Low	Grinding the edges of the plates to a radius shape
		Choose type electrodes and types polarity	Wrong choice Welding electrode	short circuit	Fire	1	1	1	Low	Supervision by the Production Manager to ensure the correct choice of electrode before starting welding.
		Prepare component of welding machine	Messy welding wires	Stumble cable	Minor injuries	1	1	1	Low	Arrange the position of cables to prevent obstruction during work

Table 6. HIRARC analysis for oil cargo tank area (cont.)

No	Activity Name	Work Activity	Hazard	Risk	Impact	L	S	R	Risk Level	Risk Control
			Wet work area floor	Slip	bruises	1	1	1	Low	a. Dry the wet floor area b. Ensure the floor is dry and there are no peeled cables

			Plate Materials	Pinched welding components	Minor injuries	1	1	1	Low	Teach safe material handling practices such as carrying together with other workers
			Welding cable is chipped	short circuit	Fire	1	1	1	Low	Check cable and electrical safety before working
		Adjusting the magnitude of welding current	welding machine	short circuit	Fire	1	1	1	Low	Check welding current according to the material before working
			AC/DC transformer	short circuit	electrocuted	1	1	1	Low	Check the transformer according to welding before working
2	Use of Welding PPE		Not wearing a welding helmet	Exposed welding beam	vision disturbance	1	4	4	High	a. Conduct *safety talks* b. Use welding helmet as PPE c. Supervise the use of PPE
			Not wearing a welding apron	Caught welding splash	Burns on the body	1	3	3	Moderate	a. Conduct *safety talks* b. Use welding apron as PPE c. Supervise the use of PPE
			Not wearing *Safety* Shoes	Caught welding splash	Burns on the leg	1	2	2	Low	a. Conduct *safety talks* b. Using PPE (*Safety Shoes)* c. Supervise the use of PPE
		Wearing Protective Gear Self	Not wearing a Mask	inhaled smoke smell	inhaled welding pollution	2	2	4	Low	a. Conduct *safety talks* b. Use Mask as PPE c. Supervise the use of PPE
			Not wearing *Wearpack*	Caught welding splash	Burns on the body	1	2	2	Low	a. Conduct *safety talks* b. Using *Wearpack as* PPE c. Supervision use of PPE
			Not wearing welding hand gloves	Burnt	Burns	4	1	4	Low	a. Conduct *safety talks* b. Using PPE : Gloves welding hand c. Supervise the use of PPE
			Not wearing Welding goggles	Exposed welding beam	Disturbance vision	1	3	3	Moderate	a. Conduct *safety talks* b. Use welding goggles as PPE c. Supervise the use of PPE
3	Welding Process	Welding of Cargo Oil Tank on the inside	Surface tank pressurized	Caught welding splash	Explode, fire	1	1	1	Low	a. Supervision to workers who do not wear masks (because PPE has been provided in the Shipyard)

Table 6. HIRARC analysis for oil cargo tank area (cont.)

No	Activity Name	Work Activity	Hazard	Risk	Impact	L	S	R	Risk Level	Risk Control
										b. Enforcement law (rebuke), change wages and bonuses if if workers are not compliant

			Installation electrode	stung electricity	electrocuted	4	1	4	Low	Supervise welding machines and use the appropriate electrodes
			Wet floor onwork area	Slip	bruises	1	1	1	Low	a. Dry the wet floor area b. Make sure floor dry and nothing frayed cable
			The hot weather	Exposed hot	Feeling hot on the skin	2	2	4	Low	Use a cooling blower in the area for air circulation
			Scattered welding cable	Stumbled	Minor injury	1	1	1	Low	Arrange the cable position so it doesn't obstruct work.
			Closed welding space	Lack of oxygen, inhaling smoke odor	Respiratory Disturbance	4	2	8	Moderate	a. Conduct *safety talks* b. Teaching how to adjust body position according to the wind direction c. Use welding *safety* PPE and Supervision use of PPE d. Enforcement law (warnings), change wages and bonuses if do not comply
			Inadequate light on welding	Welding hit hand worker	Burns	1	1	1	Low	a. Conduct *safety talks* b. Add internal lighting
		Welding of Cargo Oil Tank on the outside area	Horizontal welding work posture	WMSD	Pain in the back and shoulders	4	1	4	Low	a. Wearing help torch b. Stretch before work c. Supervision in work
			Welding flash (light radiation)	See radiation light continuously	Irritated eyes, cataracts, blindness	1	1	1	Low	a. Conduct *safety talks* b. Use welding helmetzx PPE c. Supervision use of PPE
			Scorching heat of the sun	Caught hot part	Burns	2	1	2	Low	Supervision of workers who do not wear appropriate clothing (long clothing) and Installing tarps to prevent heat stroke
			Blow Hammer Slag	hit	bruises	1	1	1	Low	Supervision of workers who do not wear Safety Goggles.
			Hot welded material	Touched	Burns	1	1	1	Low	a. Conduct *safety talks* b. Supervision by ensuring welding results
			Weld slag that is cleaned up	Caught eye	vision disturbance	1	1	1	Low	Ensure operator to wear *safety* glasses

Table 6. HIRARC analysis for oil cargo tank area (cont.)

No	Activity Name	Work Activity	Hazard	Risk	Impact	L	S	R	Risk Level	Risk Control
										protection like earplugs
			Sparks from grinder	Touched	Burns	1	3	3	Moderate	Wear *safety* PPE as well as done supervision
						1	1	1	Low	a. Conduct *safety talks*

	Caught fractions eye grinding	Serious injury bleeding					b. Providing first aid c. Workers must be more focused and cautious while working.
Grinding blade							a. Conduct *safety talks* b. Provide first aid kits
	Cut	bleeding	1	1	1	Low	c. Workers must be more focused and cautious while working.
Grinding Cable hand peeled off	stung electricity	electrocuted	1	1	1	Low	Supervise the electricity before start processing

In this study, there is one high-risk level in the upper accommodation area with a value of 10 based on the HIRARC analysis. In the upper accommodation area, there is a very high risk involved in the welding process. Welding hazards at height in the welding activity on the outer part of the upper accommodation area pose a risk of falling. The risk of occurrence in this activity is occasionally possible and is valued at 2, due to the numerous welding activities at height and the occasional interference from the wind direction during welding. Workers can suffer severe injuries, injuries, or even death in the event of a disaster, which is valued at 5, as workers can fall from heights if not careful. This assessment of the activity results in a risk value of 10 with a very high level.

The recommended risk control is the provision of administrative controls and PPE. First, a safety talk is conducted every morning before starting work as an initial effort for an emotional approach to workers about the dangers of working at height. Second, workers are taught to position themselves according to the direction of the wind and to communicate the consequences of the dangers. Third, operators are required to use mandatory PPE such as long-sleeved wear packs, safety shoes, welding gloves, welding helmets, and body harnesses as the main PPE in welding at heights. Supervision of PPE usage is also carried out by the production head, making it a priority when conducting welding at heights. Finally, law enforcement (reprimand) can be carried out, as well as changing wages and bonuses if workers do not prioritize occupational health and safety at work.

Whereas, in the cargo oil tank area, there was obtained 84% low risk levels, 13% moderate risk levels, and 3% high risk levels. In the oil cargo tank area, there is a risk associated with the use of Personal Protective Equipment (PPE). The potential hazard in this activity is the failure to wear a welding helmet, which poses a risk of exposure to welding sparks. This risk is considered rare, valued at 1, as workers are generally accustomed to wearing welding helmets. However, if they do not wear a welding helmet, the severity of the impact can lead to temporary visual impairment, valued at 4, as prolonged exposure can result in cataracts. This assessment of the activity results in a risk value of 4, indicating a high level of risk.

Risk control for work activities in the cargo oil tank area, which has the highest risk, is done through administrative controls, the use of personal protective equipment (PPE), and technical engineering controls, such as conducting safety talks, monitoring PPE usage, using recommended PPE, enforcing laws and regulations through warning or changing bonuses and wages for non-compliant workers, using cooling blowers for air circulation, and installing tarps to prevent workers from overheating.

5. CONCLUSION

Based on the results of data analysis and discussion, the results of this study can be concluded that in the upper accommodation area obtained 40 risks contained in the 4 processes of welding activities. Of the 40 risks, 31 levels of low risk, 5 moderate risk levels, 3 high risks level, and 1 very high risk level.

There are described with a percentage of 77% low risk, 12% moderate risk, 8% high risk, and 3% very high risk. Whereas in the oil cargo tank area, there are 37 risks contained in the 4 processes of welding activities. Of the 37 risks, 31 levels of low risk, 5 moderate risk levels, and 1 high risk level are described, with a percentage of 84% low risk, 13% moderate risk, and 3% high risk. Risk control in work activities in the upper accommodation area can be carried out by implementing administrative controls, use of personal protective equipment (PPE) and technical engineering controls by conducting safety talks, monitoring the use of PPE, using PPE, and using shelter assistance. Risk control in work activities in the cargo oil tank area can be carried out using administrative controls, use of personal protective equipment (PPE), and technical engineering controls by conducting safety talks, monitoring the use of PPE, using PPE recommendations, law enforcement in terms of warnings, changing bonuses and wages if workers do not comply, use cooling blowers for air circulation, and put up tarpaulins so workers do not overheat.

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